Chapter 1
Introduction to the CAVIAR Project and Framework

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Abstract This chapter provides the research rationale for the CAVIAR case studies presented in this book. The CAVIAR project is a response to the incontrovertible need for analysis of how community vulnerability is shaped by various forces across the Arctic region. The research incorporates multiple sources of knowledge which enhances our understanding of what makes communities vulnerable or resilient to change. The goals of this project are; the application of a common analytical framework to identify the social and environmental factors, processes and interactions that shape the vulnerability of a selection of communities across the Arctic; to compare results across communities in order to identify commonalities and transferable lessons; and to improve our understanding of the relationships between localised vulnerability and multiple scales of decision-making related to adaptation. The theoretical basis and conceptual framework described in this chapter provides a structure for the remainder of chapters in this book.

Keywords Climate change · Arctic · Framework · Interdisciplinary · Community-based

1.1 Introduction

The Arctic is experiencing rapid changes in both socio-economic and environmental conditions. The Arctic Climate Impact Assessment (ACIA) projected unprecedented climate change for Arctic regions, and changes have already been documented by instrumental records and local and indigenous observations (Gearheard et al. 2006; Huntington and Fox 2005; McBean et al. 2005). The Arctic Human Development Report (AHDR 2004) demonstrated that

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G.K. Hovelsrud, B. Smit (eds.), *Community Adaptation and Vulnerability in Arctic Regions*, DOI 10.1007/978-90-481-9174-1_1,

Arctic peoples are susceptible to changing environmental conditions, and are already having to adapt. Among climate related changes are projected increases in temperature and precipitation, reductions in sea ice extent, and increases in the frequency and magnitude of hazardous conditions, including those associated with permafrost thaw, sea ice stability, and increasing exposure to storms along the Arctic coasts (Barber et al. 2008; Christensen et al. 2007; Couture et al. 2002; Johannessen et al. 2004; Kattsov and Kallen 2005; Sou and Flato 2009; Zhou et al. 2009). In turn, the presence, location, and distribution of animal species and vegetation dynamics will be affected (Anisimov and Fitzharris 2001; Derocher et al. 2004; Huntington and Moore 2008; Post and Forchhammer 2008). These changes have major implications for ecosystems and for people's livelihoods and wellbeing, and they will occur in the context of ongoing social, cultural, economic, and political transformations in northern communities (Anisimov et al. 2007; Fenge 2001; Ford and Smit 2004; Rattenbury et al. 2009).

While there is general agreement that changes in climate, and associated conditions, are likely to pose significant challenges for communities, the nature of these risks and the most effective means of dealing with them are poorly understood (Duerden 2004; Ford and Smit 2004; McCarthy and Martello 2005; Nuttall 2001, 2005; Schneider et al. 2007). The Community Adaptation and Vulnerability in Arctic Regions (CAVIAR) project was designed with the intent to document the particular environmental conditions to which local communities are sensitive; to assess the strategies employed to deal with changing conditions in communities across the Arctic; to identify the conditions that facilitate or constrain the adaptive capacity or resilience of Arctic communities; and to integrate information from local and indigenous knowledge with scientific knowledge to understand the nature of opportunities to better deal with changing conditions. Insights into sensitivities, vulnerabilities or resilience of communities generated through CAVIAR research are uniquely positioned for comparison across Arctic countries and are well suited for decision-makers and policy in Arctic regions.

The pan-Arctic CAVIAR consortium works in separate teams in all eight Arctic countries and is unified in terms of its rationale, goals, conceptual basis, analytical approach, integrative methods, structure for comparison and synthesis, and practical applications. This introductory chapter is based on the CAVIAR framework document (Smit et al. 2008), which was an outcome of the proposal document 'A Pan-Arctic Research Framework' (February 2006) and the CAVIAR Consortium Workshop (Oslo, October 2007). In this chapter we outline the CAVIAR framework that provided a context for case studies carried out during International Polar Year 2007–2008 (IPY), many of which are presented in this book. Through the use of a common framework, CAVIAR case studies have enabled an *ex ante* inter-community comparison and synthesis across the circumpolar north. The assessment of vulnerabilities and adaptations has been identified as a priority area for research by policy makers, local and indigenous communities, the Arctic Climate Impact

Assessment (ACIA), the Arctic Human Development Report (AHDR), and the International Polar Year planning committee (ACIA 2005; AHDR 2004; Government of Nunavut 2003; Rapley et al. 2004; ICARP 2005; NRI 2002; Watt-Cloutier et al. 2005). In particular, the following have been identified as important research questions:

- What aspects of people's livelihoods are at risk, and to what?
- What conditions are problematic for people and the ecosystems on which they depend?
- What changes can be accommodated by existing ways of life?
- What is the ability of local communities to manage changing conditions?
- What local and external factors influence vulnerability and in what ways?
- What are the critical thresholds of adaptability or resilience?
- How do social, cultural, economic, and political processes operating at multiple scales affect sensitivity to climate change and adaptive capacity?
- What is the effectiveness of adaptive strategies across the Arctic?
- How do conditions affecting communities and their adaptive capacities vary among communities?
- What can be done to enhance community adaptability?
- How can lessons be shared among Arctic communities?

CAVIAR has responded to the need for developing and applying a framework that analyses how vulnerability is shaped by various forces or drivers across scales from local to global. The research incorporates multiple sources of knowledge to enhance understanding about what makes communities vulnerable or resilient to change (Ford et al. 2008; Huntington 2000; Laidler 2006; Pearce et al. 2009; West and Hovelsrud in press). CAVIAR was designed to address the need for identifying practical opportunities to enhance communities' adaptive capacities, or to promote their wellbeing or sustainability.

1.2 Goal and Objectives of CAVIAR

The underlying purpose of CAVIAR is to better understand how Arctic communities are affected by environmental changes in order to contribute to the development of adaptive strategies and policies. The broad goal of the CAVIAR research program is to enhance the theory, empirical understanding, and practical application of processes that shape adaptation and vulnerability in communities across the polar region by:

- further developing the concept of vulnerability (e.g. Chapin et al. 2004; Smit and Pilifosova 2001; Turner et al. 2003; Tyler et al. 2007) and refining an integrative interdisciplinary research framework for vulnerability studies (e.g. Huq and Reid 2004; Keskitalo 2004; Kruse et al. 2004; Polsky et al. 2007; Smit and Wandel 2006),

- applying the framework to a selection of communities across the Arctic region to identify the social and environmental factors, processes and interactions that shape differential vulnerability and adaptive capacity,
- comparing results among Arctic communities to identify commonalities and transferable lessons, and
- improving understanding of interrelations between local vulnerability and decision-making related to adaptation, across multiple scales from local to international.

CAVIAR research is more than data collection or monitoring of change; it involves interdisciplinary integration and collaboration with Arctic community partners, in order to characterize vulnerabilities or risks, to document the processes and forces that facilitate adaptation or management of risks, and to identify and evaluate means to improve the capacity of communities to adapt to changing conditions. By undertaking studies in communities in all of the Arctic countries, using a common research framework and consistent methodologies, the program is able to compare results and synthesize findings across the circumpolar north.

1.3 Research Strategy

The research program has been undertaken by an international interdisciplinary team, representing all the Arctic nations. The team has built upon existing research initiatives, operating independently in their local (case study) applications, but with common goals, concepts, research framework and consistent methodologies. The comparison and integration is based on the case studies. Team members, along with stakeholder representatives, partner agencies and organizations and local communities, implement the CAVIAR research program. The main components of the CAVIAR program are outlined in Table 1.1.

1.3.1 Theoretical Basis and Core Concepts

Recent research in the human dimensions of global change and natural hazards communities has noted the importance of locally grounded, context-sensitive assessments (e.g. Flax et al. 2002; Smit and Wandel 2006; Stephen and Downing 2001). Although actions on adaptation are taken at scales from individual to national, community-based assessments are a necessary step to formulating effective strategies to address climate-related challenges in Arctic regions.

Several conceptual models of community sustainability, resilience, risk and vulnerability have common elements (Flax et al. 2002; Ford et al. 2006; Schröter et al. 2005; Turner et al. 2003). Given the importance of climate change in Arctic regions, and the formal recognition of vulnerability in the United Nations

Table 1.1 Main components of the CAVIAR program

Conceptual framework	Develop a conceptual framework for community vulnerability, including the role of exposures and sensitivities to multiple stresses and the adaptive capacities or resilience of communities.
Methodological approach	Refine a common methodological approach that is stakeholder-based, systematic, and draws upon traditional and local knowledge and scientific knowledge in order to document exposures and adaptive capacity or resilience (and their broad determinants) of selected communities in a consistent fashion.
Case studies	Establish procedures for case study selection and implementation of community case study vulnerability assessments with northern collaborators across the Arctic region.
Comparison and integration	Develop and implement a process to compare and integrate results from the case studies for a pan-Arctic assessment of community vulnerability and adaptability.
Policy relevance	Application to policy and decision-making relating to community adaptive capacity, by ensuring that the research scope and approach substantively include institutions and governance structures.
Outreach	Incorporation of on-going, substantive stakeholder engagement and partnerships so that outreach is an integral feature of the vulnerability assessment.

Framework Convention on Climate Change (UNFCCC) (Smit and Wandel 2006), CAVIAR employs the term 'vulnerability' as its central concept. CAVIAR is interested in the overall wellbeing or sustainability of communities and their susceptibility or vulnerability to changing conditions. *Vulnerability* refers to the manner and degree to which a community is susceptible to conditions that directly or indirectly affect the wellbeing or sustainability of the community. This includes the sensitivity of the ecosystem of which the community is part or on which the community depends. Use of this term does not presume that communities are particularly vulnerable – some may have relatively few or no vulnerabilities. Vulnerability is a function of both exposure-sensitivity and adaptive capacity (Adger and Kelly 1999; Ford and Smit 2004; Keskitalo 2008; Kofinas 2005; Smit and Pilifosova 2001; Turner et al. 2003; Wisner et al. 2004).

Exposure-sensitivity refers to the manner and degree to which a community is sensitive to and exposed to particular conditions, forces or stresses. It reflects the likelihood of climatic conditions or natural hazards occurring in a particular place over time relative to the situational characteristics of places and people which make them sensitive to the conditions or hazards. Thus, exposure-sensitivity is related to the susceptibility of people or livelihoods to a stimulus, the dynamics of the potential stimulus or stress, and the community's physical location, social and economic situation, governance and political systems. *Adaptive capacity* is closely related to resilience, and reflects an individual's or community's ability to cope with, adjust to or recover from an exposure-sensitivity. It is reflected in the community's management of current

and past stresses, its ability to anticipate and plan for future change, and its resilience to perturbations.

A community's exposure-sensitivity and adaptive capacity reflect the interactions of local conditions and forces at *broader scales*. Broader environmental processes have local manifestations, and the particular local conditions which shape exposure-sensitivities and adaptive capacity reflect regional, national and global social and economic conditions or trends. The functional relationship between exposure-sensitivity and adaptive capacity will vary by context and over time, but it is understood that vulnerability is positively related to exposure-sensitivity and negatively related to adaptive capacity.

1.3.2 Methodological Framework

1.3.2.1 The CAVIAR Approach

The core research has been undertaken in case study communities. Communities were selected to cover a range of Arctic communities, and their selection was influenced by characteristics such as size, location, economic orientation, social-cultural composition, and practical matters such as access, local interest or research fatigue.

By employing a common framework and consistent methodologies, the case study data or insights are in a comparable structure. Such consistency is a necessary requirement for case studies to be included in the *ex ante* comparative meta-analysis (Rudel 2008).

One of the intentions of the research is to be beneficial and relevant to the communities, and to achieve this a close collaboration with community members and local stakeholder is critical (e.g. Gearheard et al. 2006; Hovelsrud and Winsnes 2006). The methodological approach for empirical studies of community vulnerability case studies is based on the principles outlined in Berkes and Jolly (2001), Ford and Smit (2004), Keskitalo (2004), Lim et al. (2004), Pearce et al. (2009) and Turner et al. (2003). The methods applied in CAVIAR are based on the notion that a crucial aspect of a vulnerability assessment is to gather and understand the stakeholders' own information on their exposure-sensitivities and adaptive capacity. The open, unbiased and active engagement of the community representatives and other stakeholders is a necessary element of this approach. This process is consistent with the principles of community based adaptation (CBA) and 'bottom-up' approaches increasingly used in vulnerability and adaptation projects (Dessai and Hulme 2004; Flax et al. 2002).

Background information on the community, also known as baseline information, is compiled and preliminary interviews with key stakeholders are undertaken to gain an appreciation of the broad features of the community that relate to vulnerability. If the case study needs to be limited in scope due to community size or some other consideration, the scoping phase may also identify major areas of interest or focus. This phase also establishes likely

sources of information (records, documents, measurements, individuals, etc.), the procedures for selection of collaborators, and the community-appropriate processes for data gathering from the community members (sampling, interview schedule, focus groups, etc.). Depending on the community and, in some cases, the sector or group in the community, interviewees include residents, practitioners, administrators or group representatives.

Each case study broadly addresses a common set of questions:

1. In what ways are communities affected by changing conditions? i.e. How, to what and why are people and their livelihoods sensitive or vulnerable to changing environmental conditions (including climate) and socio-economic conditions?
2. How do communities adapt to changing conditions? i.e. What are the processes, players and strategies of adaptation or adjustment, by individuals, groups and organizations, and what are the implications of those adaptations?
3. What changes can be expected in the future in the conditions that affect the community? i.e. In what ways are the vulnerabilities likely to change in the near and long-term futures, and how will they affect the community?
4. What capacity does the community have to deal with future changes? i.e. What resources, institutions, and types of capital does the community have to adapt, what adaptive opportunities are there, and what are the limits and constraints on adaptation, on all levels?

In this book, a 'vulnerability case study' refers to an investigation of the four sets of questions for a particular case community. Some case studies focus on a selection of these questions, rather than cover all four sets. The CAVIAR framework is designed to:

- guide the analysis of these four central questions in each case study,
- provide a structure for reporting case study results, and
- facilitate comparison and integration across case studies.

Once a community has been selected, community members have endorsed the process, and local collaborators are familiarized (or trained) with the approach and methods, data gathering begins. The information sought relates to the items contained in the four research questions, usually in sequence from top to bottom in Fig. 1.1.

Figure 1.1 illustrates the relationships between the main categories of information needed in a vulnerability assessment of any community. The four core components of the framework correspond to the four questions presented above. The researchers first document past and *current exposure-sensitivities* (question 1) in order to identify the conditions that are of particular relevance to the community. They also (often concurrently) identify and document the *adaptations strategies and processes* (question 2) to describe the ways in which communities have managed the conditions to which they are exposed and sensitive. Together, these characterize current vulnerability. They also provide

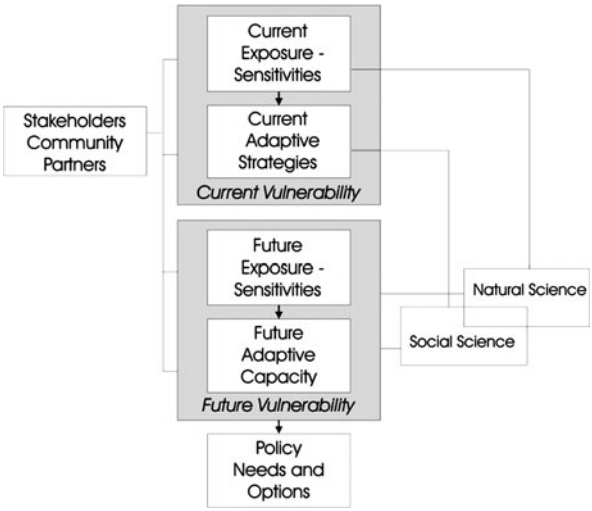

Fig. 1.1 Key elements in the CAVIAR vulnerability assessment framework

the basis for estimating future vulnerability (both *future exposure-sensitivity* and *future adaptive capacity*). This involves assessing the likelihood of changes in the conditions that are pertinent to the community, drawing on scientific projections of change in natural and social systems and characterizing the scope and limits to adaptive capacity. The assessment of future risks and prospects for adaption provides the basis for collaboratively identifying *policy needs and options* and the initiatives that could enhance the capacity of the community to adapt.

1.3.2.2 Current Exposure-Sensitivities

The first research task is to document the conditions and processes that represent *current exposure-sensitivities*. This requires the identification of forces, stresses or processes which affect the livelihoods or wellbeing of people in the community. It also requires providing evidence of the exposure-sensitivities and explaining the processes and trends that underlie them. Some conditions may be important for the whole community, while in other cases only as a certain group or sector may be sensitive to a change or condition.

For example, a community may be sensitive to changing sea ice conditions (timing of freeze-up and break-up, thickness, etc.) because of its dependence on sea ice for traveling to hunting grounds (providing food, livelihood) and the related cultural importance of participating in subsistence activities. Changes in the timing of freeze-up and break-up and less predictable ice conditions (e.g. thickness, location of leads and polynyas) introduce greater hazards for snowmobile travel. This exposure-sensitivity reflects the nature of the community's society and economy, technology, the physical location and the dynamics of ice, ocean and atmosphere. This exposure-sensitivity can be described by outlining the underlying processes, interactions among these processes, and

evidence of these. This might include documenting the degree to which community members are reliant on hunting and on sea ice, and where current travel routes are. Insights may be gained from data on the contribution of animals hunted on (or via travel on) sea ice to the food and incomes of residents, and data on changes in sea ice dynamics and travel conditions (e.g. snowmobile vs. sled dogs). Relationships between sea ice dynamics and climate and ocean conditions could also be documented, as could changes in alternative food sources and the wage economy which affect the role of hunting in Inuit livelihoods. Other exposure-sensitivities might relate to resource development, wildlife dynamics and availability, or infrastructure and permafrost changes. It is important to note that, to ensure comparability between studies in CAVIAR, exposure-sensitivities are identified empirically from insights and evidence gathered in the community – they are not assumed a priori or derived arbitrarily or exogenously from hypotheses or models.

1.3.2.3 Current Adaptive Strategies

The second research task (Fig. 1.1) is to identify and assess the *current adaptive strategies* or management responses employed in the community to deal with the identified exposure-sensitivities. This involves describing and documenting the ways in which individuals, groups or organizations have adapted to the conditions and changes that have affected them. Understanding adaptations entails outlining the specific adaptive measures or actions and the broader processes of which they are part.

For example, adaptations to sea ice exposure-sensitivities might include changing travel routes, changing timing or location of hunting, seeking alternative income sources, securing alternate food sources, and employing remote sensing data and VHF radio and global positioning systems (GPS). These strategies can be documented and explained relative to the employment situation, available transportation technologies, food preferences, etc. In addition, adaptation strategies can be assessed according to their consequences and implications. For example, securing alternative food sources in a diet requires financial resources to purchase southern foods at the store, and these in turn have implications for people's health. Changing the timing or location of hunting may not be an option for people with insufficient time flexibility (due to participation in the wage economy) or who are unable to cover additional costs of equipment or fuel.

Information on aspects of current vulnerability (exposure-sensitivities and adaptive strategies) are acquired from community residents directly and from secondary sources such as existing documents, reports and other inventories, and data from community-based monitoring. In addition, researchers draw on instrumentally gathered records of conditions pertinent to the livelihoods and lives of community members (e.g. long-term climate records and federal population censuses). Information from these sources is integrated by interpreting the data relative to the research questions – that is, what is known about exposure-sensitivities and adaptive strategies.

1.3.2.4 Future Exposure-Sensitivities

The collection of information about future vulnerability (Fig. 1.1) involves both scientific assessments and community insights. Ideally, estimates of *future exposure-sensitivities* (question 3) will be determined via two routes. First, the conditions identified as current exposure-sensitivities are analyzed in order to estimate possible changes, trends or probabilities of change in those conditions in order to describe the ways in which existing exposures might change in the future. Second, possible changes in conditions from climate (or other) scenarios are specified regardless of whether they were identified by community residents or not. For example, future changes in travel opportunities relative to sea ice conditions could be estimated by applying scientific knowledge of ice dynamics to trends and expectations in break-up and freeze-up time relative to harvesting areas and travel routes. This could include insights from climate change scenarios linked to cryosphere and oceanographic models applied to the locations and conditions of importance a community. This analysis of future exposure-sensitivities could also include using information from those who rely on sea ice, such as hunters, to identify the types and degrees of change in ice conditions that residents would find particularly problematic, thus providing specific targets for probability estimates of future ice conditions.

1.3.2.5 Future Adaptive Capacity

The future exposure-sensitivities are then examined in terms of the community's *future adaptive capacity* (question 4), with information gathered from community members' responses to presented future exposures, from key informants involved in the institutions, risk management processes, resource management structures and policies related to adaptive capacity, and from social sciences that might bring insights from elsewhere on the nature of community adaptive capacity and resilience. The analytical task is to identify the conditions in the community (various forms of assets, capital, technology, institutional arrangements, etc.) that would either facilitate or constrain adaptation. This could include describing the ways in which economic conditions or institutional arrangements (for example) could accommodate the changing conditions, or perhaps are unable to deal with certain types of changes.

1.3.3 Community Vulnerability Case Study Methods

A variety of research tools and methods have been employed in community case studies to identify, describe and explain each of the items in the CAVIAR framework. The framework indicates the types of information to be gathered; this section provides an outline of ways in which the information has been acquired.

The information gathered in the four core elements of the framework (Fig. 1.1) matches the four research questions outlined in Section 1.3.2. These four bodies of information, if gathered in a consistent manner in each of the case communities, provide the 'data' to be analyzed and synthesized in the pan-Arctic inter-community comparative exercise (see Section 1.3.5). The comparison seeks to identify exposure-sensitivities and their driving forces that are common to several communities, and to indicate how and why these are distinct in some places or types of society/economy. The comparative exercise also serves to identify adaptive strategies and processes that have been effective (or otherwise) as a basis for sharing lessons among communities across the Arctic regions, and for relating findings directly to decision-makers and policy processes from the local to international scales.

Table 1.2 outlines key elements in the process of community-based vulnerability assessment consistent with the CAVIAR framework. The elements reflect what was done (e.g. assessing exposure-sensitivity), who did it (e.g. researchers, stakeholders) and what data sources were used (e.g. interviews, climate records).

CAVIAR case studies involve research with and about people in communities, and establishing mutually supportive collaborative arrangements was a necessary first step (Table 1.2). This usually entailed preliminary field visits for information exchange, approvals, research planning and scheduling, identification of local research collaborators, protocols, fees, etc.

The data gathering from community residents on exposure-sensitivities and adaptations (Table 1.2) involved a variety of methods frequently used in ethnography, sociology, social anthropology, geography, resource management, health research and sustainability and development initiatives. *Participant observation* and taking temporary residence in the community were part of the procedure in some of the cases. Commonly, *semi-structured interviews* were conducted in the local language (frequently by a community collaborator). In CAVIAR the interview usually had a loose structure, but generally aimed to acquire insights into:

- The general situation of the interviewee: livelihood, socio-economic situation, living conditions, etc. The subsequent four elements relate directly to CAVIAR's four questions and components (Fig. 1.1).
- The conditions, environmental and otherwise, to which the interviewee is sensitive, or which are important in some way, or by which the interviewee has been affected or impacted.
- The strategies, coping mechanisms or other measures employed by the interviewee to deal with, cope with, respond to or recover from the conditions identified, including the reasons for these strategies being employed and not others.
- The interviewee's assessment of future changes in conditions, including those provided by natural science scenarios, particularly as they relate to him/her.

Table 1.2 Activities, data sources and actors in CAVIAR case studies

Stage	Activities	Data sources	Actors
Facilitation/ legitimization	• Field visit to establish legitimacy/ acceptance • Identify local partners, collaborators, terms, issues, sensitivities, protocols and schedules	• Published literature • Key informants	• Natural and social scientists with community representatives and local collaborators
Current and past exposure-sensitivities	• Field visit • Data collection • Documentation	• Available secondary sources • Remote sensing info • Climate record • Archival records • Interviews • Focus Groups • Traditional/Local Knowledge	• Social and natural scientists with local collaborators
Current and past adaptations and capacities	• Field visit • Data collection • Documentation	• Available secondary sources • Remote sensing info • Archival records • Interviews • Focus Groups • Traditional/Local Knowledge	• Social scientists with local collaborators
Future exposure-sensitivities	• Field visit • Modeling • Projections • Probability estimation	• Scientific experiments and models • Interviews • Focus groups	• Social and natural scientists with local collaborators
Future adaptations and adaptive capacity	• Field visit • Social science predictions	• Social science models • Interviews • Focus groups	• Social scientists with local collaborators
Integration (overall vulnerability)	• Analysis • Interpretation	• Field results and secondary sources	• Natural and social scientists
Feedback/ dissemination	• Field follow-up visit • Media • Scholarly publications	• Case study outcomes	• Natural and social scientists with policy-makers and collaborators
Comparison/ integration	• Integration of circumpolar cases	• Individual case study outcomes	• Natural and social scientists with policy-makers

- The interviewee's expected ability to adapt to or deal with changes in conditions, including those broader factors that may be necessary for certain strategies or those that may constrain options.

A *focus group* format was also used in some cases to gather the information about exposure-sensitivities and adaptive capacities, either as an alternative or parallel exercise or as a follow-up method to interviews of residents or key informants. The information gathered from interviews with community members was supplemented by information relating to current and future exposures and adaptive strategies/capacity from other available sources including archival records, institutional measurements, and traditional or local knowledge.

In addition to information from community members, insights and evidence relating to vulnerability and adaptation were incorporated from other sources. For example, data on changes in the timing of sea ice break-up in or near a community may have been available from instrumental or satellite records, or from documents kept by local organizations, archives or businesses. Data on changes in food choices may have been available from the community retail stores, and information on changing diets may have been available from the health clinic or health surveys. Information on likely future changes in ice, wildlife, permafrost and climate has been acquired from natural science analyses and scenarios. Information on the decision-making structures and processes and their capacity to incorporate adaptations were often available from analyses of institutions and governance and from organizational respondents and other stakeholders. Data from these sources were combined with the information gathered from the community members themselves to address each of the components of the CAVIAR framework. In addition, an overall integration of the case-study findings is being undertaken (Table 1.2) to generate interpretations and summaries of the results.

The insights gained on the nature of vulnerability, on adaptation needs, and on constraints to adaptation, provide a robust basis for identifying practical interventions to reduce exposures and/or to enhance the community's capacity to adapt. The initiatives may involve risk management strategies, community planning, resource management plans or regulations, technology, and policies at levels from the community to national and international institutions. Ideally, the process of identifying and developing *adaptive strategies* is undertaken with the participation of community members and stakeholders.

The *feedback* phase is still in progress in some case studies and involves supplying the community with information gained from the research. In practice this occurs throughout the field research (keeping the community informed about the broad goals and findings), and especially after the results have been analyzed. A common form of feedback consists of a return visit to the community to provide a summary of results (and related insights from other work) through local radio, website, newspaper, community gathering/feast, school visits, briefing with local officials etc. – the appropriate means vary per community.

In addition, several community collaborators participated in workshops, conferences or media events beyond their own community to disseminate findings more widely and to influence policymakers, and to benefit from initiatives that take place occurring outside of their community.

1.3.4 Policy

The relevance of the CAVIAR research to policy is explicit and substantive. The research focuses directly on environment-society issues that are important to northerners, it includes decision-making processes and institutions as subjects of the research, and it involves policy decision-makers in the research itself.

The CAVIAR research program is directly policy relevant in several ways:

- It engages community representatives and decision-makers in the research process to ensure that the items analyzed are pertinent to community members and relevant to community decisions. This engagement orients the research to those issues that are policy relevant, and it facilitates the application of the results by decision-makers.
- A fundamental step in the vulnerability assessment methodology is to identify the ways in which the community's members, institutions and governance structures deal with stresses and environmental changes, so that analyses of adaptive capacities and adaptation options are undertaken explicitly in the context of actual decision-making structures and policies. The research includes rigorous analysis of policies and decision-making as part of the vulnerability assessment, contributing to the direct policy relevance of the results.
- The CAVIAR initiative includes partners representing organizations involved in policy making at several levels, ranging from international organizations, national and regional government agencies to indigenous peoples' organizations and community-based organisations (e.g. Hunters and Trappers Organizations). These partnerships not only facilitate CAVIAR research, but they also provide influential entry points to policy processes at all scales.

1.3.5 Outreach

The vulnerability assessment methodology in the CAVIAR consortium sought to actively engage people in northern communities. This meant going beyond the inclusion of community members as research subjects or field research assistants and involving them as collaborators and partners. This method represents an important outreach component, ensuring that research is locally relevant and that community members are part of the process and well

informed of the findings. The CAVIAR team is further committed to dissemination in communities, employing means which are targeted to the respective audiences, including (but not limited to) community meetings, radio, magazines, schools, television, reports, brochures, and briefings.

1.3.6 Case Studies

Framework and methodological development were developed collaboratively within the CAVIAR consortium (through workshops, communications and document development). The case study research was conducted independently by research teams organized in national nodes, with primary research funds coming from the respective national agencies or bi-national agreements. In most cases, CAVIAR members acquired supplementary funds or resources for supporting CAVIAR research. Communities were involved in the field work at all stages, to the extent possible, and consequently became partners in the research. Consortium partners have developed their own partnerships with relevant researchers, institutes, organizations, and communities as part of their research activities.

The CAVIAR research program focuses on people and their livelihoods in communities. The term community has long had a range of contested meanings. For the purposes of CAVIAR, a northern/local 'community' is viewed as a collection of individuals and families sharing a geographic space, frequently being a town or village, with its associated formal and informal institutions. This interpretation of community includes all those who physically share the space for all or part of the year, regardless of diverse interest groups occupations, livelihoods, activities, and existence or lack of kinship ties.

It follows from the definition of a community as people in a shared geographic space with diverse membership and interests that there is no single voice for a community (Wallerstein 1999). Communities are not homogenous or monolithic entities, and thus the selection of people to represent a northern community was made with the intent to be representative (of at least some significant, defined portion) of the community. It was not expected or assumed that all people in a community have similar vulnerabilities. The research documented the types of exposure-sensitivities and adaptive strategies that vary within and between communities, as well as those that might be common in a community.

CAVIAR case studies were selected by individual researchers with knowledge and contacts in particular regions (in consultation with coordinating lead researchers) to be broadly representative of the range of communities in the circumpolar north. The case studies employed the common CAVIAR framework outlined, with the field methodologies adjusted to fit particular contexts and communities. The suite of vulnerability case studies presented in this book are displayed in Fig. 1.2.

Fig. 1.2 The CAVIAR case study localities described in the book. *Source*: compiled by Winfried K. Dallman

1.4 Features of CAVIAR and Outline of this Book

The CAVIAR research program is distinctive in several respects. Research addressing each of these areas is not new, and several of them have been investigated in the Arctic context. What makes CAVIAR distinctive is that its scope and structure allow for all of these studies to be addressed in a systematic, integrated program. This is made possible by drawing on the experiences of researchers and practitioners who have developed the various elements and by focusing on a particular application (Arctic communities). The noteworthy features of CAVIAR are:

- It explicitly addresses issues that involve complex interactions among ecological and human systems and processes. Not only does CAVIAR

consider physical, biological and socio-economic variables, but it systematically explores the links between natural and dynamic human systems.
- It is directly applied to human decision-making and policy relating to environmental changes and human communities. It brings integrated science to bear on adaptive decision-making on levels ranging from local to international.
- It is fundamentally inter-disciplinary, in that each case study involves social and natural science in addressing a common set of questions.
- It applies multiple methods in that it combines a variety of analytical tools and methods from both natural and social sciences for data collection, analysis and interpretation.
- It assesses current and past conditions and considers implications for the future – thus combining historical analysis, comparative static analysis and prospective analysis.
- It is community-based and community-engaged, to ensure that the research is founded on the experiences of local residents and that its findings are relevant to their lives and the environments in which they live.
- It is both place-specific in its provision of insights in each community case study, and regionally generic in its systematic comparison and integration of findings over many communities in the Arctic.

These themes (human-ecological integration, policy relevance, interdisciplinarity, past and future perspectives, community engagement, comparisons, etc.) do not represent independent goals of CAVIAR. Rather, they have enabled the project to address its core goal of identifying practical adaptation strategies and policies to help Arctic communities deal with changing environmental conditions. Overall, CAVIAR represents an ambitious and distinct program of interdisciplinary research to identify insights essential for the development of adaptive responses to changing conditions in the Arctic.

This book provides results from 16 case studies in Chapters 2–13. This introductory chapter has presented CAVIAR's objectives, underlying theoretical orientation, and shared framework and approach. In Chapter 2, Grete K. Hovelsrud, Halvor Dannevig, Jennifer West, and Helene Amundsen synthesize the consequences of changing climatic societal and conditions for three communities in northern Norway. Exposure-sensitivities and adaptive capacity are discussed in the context of fisheries and municipal planning, and downscaled climate projections are utilized for assessing future vulnerabilities. In Chapter 3, Mark Andrachuk and Tristan Pearce compare and contrast the communities of Ulukhaktok and Tuktoyaktuk in the western Canadian Arctic. The two communities have some similarities due to a shared culture and reliance on subsistence harvesting, but differ in their geographical setting and economic development which has shaped unique vulnerabilities in each community.

Chapter 4 by Tatiana Bulgakova documents reindeer herders' experiences with climate change in the Yamalo-Nenets Autonomous Okrug and Nenets Autonomous Okrug in Russia. Bulgakova highlights the flexibility and

adaptability of the traditional reindeer herding economy and concerns among herders about the magnitude of stresses they will face due to climate change. In Chapter 5, James Ford, Trevor Bell and Dominique St. Hilaire-Gravel focus on infrastructure vulnerabilities in Arctic Bay, Nunavut, Canada. The study identifies several adaptive strategies that have been employed to minimize risks to infrastructure due to landscape hazards. Chapter 6 by Anna Stammler-Gossmann examines the social and cultural factors that influence the ways that communities in the Nenets Autonomous District of northwest Russia perceive and respond to environmental and societal change. In Chapter 7, Sonia Wesche and Derek R. Armitage reveal how relationships with water shapes current and future vulnerabilities for land users in Fort Resolution in the western Canadian sub-Arctic. The chapter concludes that future adaptation to climate change and pressures for resource development requires engagement of actors at multiple levels and incorporating different knowledge systems.

Chapter 8 is a presentation of colour photographs that showcase examples of culture, livelihoods and vulnerabilities in the case studies.

In Chapter 9, Monica Tennberg, Terhi Vuojala-Magga and Minna Turunen document experiences with an extreme flood event in the town of Ivalo in Finnish Lapland. The case study demonstrates how recent infrastructure developments have lead to greater flood risks for the community and how communication before and during flood events is a critical adaptation to future flood events. In Chapter 10, Ralph Matthews and Robin Sydneysmith draw on new institutional analysis as a means of assessing institutional capacity in Whitehorse, a city in Yukon, Canada. The chapter explores the processes by which adaptive responses take shape in relation to infrastructure, public health and safety, land use planning, emergency preparedness and the environment. Chapter 11 by Christina Goldhar and James Ford describes the vulnerability of food systems in Qeqertarsuaq, Greenland in the context of changing livelihoods and climate change.

With a focus on land use conflicts, Chapter 12 by Carina Keskitalo examines exposure-sensitivities and adaptive capacity in the forest-dependent Gällivare municipality in northern Sweden. The chapter reveals how stakeholders in forestry, reindeer husbandry and tourism are similarly influenced by each other, as well as land use regulations and changes in climate. In Chapter 13, Stine Rybråten and Grete K. Hovelsrud describe the relationship of sheep farming and reindeer herding with climate change. The chapter describes how recent landscape changes due to moth larvae outbreaks related to climate change influence livelihood opportunities and challenges for animal husbandry.

The book concludes with an integration chapter (Chapter 14) that summarizes the breadth of communities across the Arctic. The final chapter offers key insights from the case studies on exposure-sensitivities, adaptations, and adaptive capacity across the Arctic. The final chapter also reflects on the concepts and methods used in CAVIAR.

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